

UNITED STATES DEPARTMENT OF AGRICULTURE  
FOREST SERVICE

ANNUAL INVESTIGATIVE REPORT FOR 1930 AND  
PROGRAM FOR 1931  
CENTRAL STATES FOREST EXPERIMENT STATION



ANNUAL INVESTIGATIVE REPORT FOR 1930 AND  
PROGRAM FOR 1931

CENTRAL STATES FOREST EXPERIMENT STATION

-----  
Staff

Permanent Members

E. F. McCarthy-----	Director
J. T. Auten-----	Silviculturist
Leonard F. Kellogg-----	Associate Silviculturist
Ralph K. Day-----	Assistant Silviculturist
*Leonard I. Barrett-----	Assistant Silviculturist
Ruth G. Ent-----	Senior Clerk
Mary Jane Nimocks-----	Junior Clerk-Stenographer

Collaborators

Edgar N. Transeau-----	Ohio State University
Homer C. Sampson-----	Ohio State University

Field Assistants

Harris M. Benedict
A. G. Chapman
Albert F. Dodge
Morris A. Huberman
John E. Keefus
Ben Lucas
Marion C. Smith
Robert O. Sowash
Karl F. Thielking

\* Transferred to Appalachian Forest Experiment Station  
effective January 1, 1931.

CONTENTS

General . . . . .	2
Administration . . . . .	4
Research Facilities . . . . .	4
Personnel . . . . .	4
Distribution of Expenditures . . . . .	5
Distribution of Field Time by States . . . . .	5
Working Centers . . . . .	6
Cooperation . . . . .	6
Investigations . . . . .	7
Plantation Study . . . . .	7
Relation of Grazing to the Farmwoods . . . . .	15
Oak Study . . . . .	22
Forest Types . . . . .	22
Erosion . . . . .	22
Private Forestry . . . . .	22
Study of Forest Litter . . . . .	23
Program for 1931 . . . . .	24
Reports and Articles . . . . . 1930 . . . . .	29
Project Sheets . . . . .	30-36

Annual Investigative Report for 1930 and

Program for 1931

Central States Forest Experiment Station

GENERAL

Regional Forest Needs

Production of forest crops in the central group of states is far below the capacity represented by the amount of forest land in these states. An aroused public interest is needed to bring the extensive acreage of idle land back into forest production to check the present heavy expenditure for timber supplies grown in other states.

The seven states - Ohio, Indiana, Illinois, Iowa, Missouri, Kentucky and Tennessee, consumed during 1924, 7,438,156 M board foot of lumber, of which 1,395,298 M board foot, or less than one-fifth of the timber used, was produced within this group of states. More than 80 million dollars was spent for freight alone, on lumber brought in from other regions. A comparison of the per capita consumption of 925 board feet of lumber in the three Pacific states with 269 board feet in this region shows chiefly the effect of freight rate in checking consumption. The \$16 to \$25 cost of shipping lumber from the Pacific coast prevents the free movement of low grade material into the region from the west and adds to the cost of construction.

Since the reserve of standing timber is largely on the west coast, price will be determined largely by the cost of production and delivery from there. This is true in spite of the comparatively heavy cut in the southern pine region and increased lumber production from second-growth materials. The cost of transportation from the west coast cannot be materially reduced. It is also logical to expect that the cost of production will increase as the supply of standing timber becomes less accessible and that this will be reflected in increased cost of lumber to consumers in this region.

The present condition of dependence of the central states on Pacific coast timber must necessarily be aggravated during the next thirty years. At the end of that period this region can have done a great deal to help itself by putting its forest land to work. The differential in freight charge is the best assurance of profit in growing timber at home.

## The Central States Forestry Congress

Plans initiated at the last meeting of the Central States Forest Research Council resulted in the calling of the first Central States Forestry Congress at Indianapolis on December 3, 4 and 5, 1930. The amount of public support given this first meeting of the Congress makes this body the most effective instrument in the region for the promotion of all phases of forest production and use. The Research Council may well accept its responsibility and undertake to guide the Congress in its constructive work, at least through several meetings.

## The Research Job

The program of forest research for the Station has been designed to undertake the most urgent problems first, in full realization that the combined forest research resources of all agencies in the region are inadequate to furnish quickly a sound basis for the immediate organization of the forest land of the region.

This land may be classed into three major groups, none of which are now producing a return in proportion to their intrinsic value.

1. Second Growth Forest. This varies in character dependent upon the severity of previous cutting, the amount of damage by fire and the proportionate space occupied by cull trees and poor species.

2. Farmwoods. In the corn belt these are more than 90 per cent pastured and already a great percentage has gone beyond repair. The local establishments which once furnished a market at home for farm timbers have largely disappeared.

3. Abandoned Fields and Land of Low Agricultural Value. These are rapidly eroding to a condition where they will grow only inferior forest crops.

Each of these classes of forest land presents a great number of unanswerable questions and the collection of information for the answers is the job of research.

Cut-over forest land must be inventoried and mapped to show the types, age classes and condition of the timber. In addition, the growth rate, reproduction, and method of management must be studied to furnish the basic information upon which the wood-using industries can be reconstructed.

The farm woodland is doomed to final destruction unless the attitude of owners with reference to grazing can be changed. The final solution of the farm woods problem may require a compromise with grazing which will permit grazing during periods when the stand is not being reproduced.

Abandoned land once cultivated, in one county (Vinton) in Ohio, amounts to 70,000 acres. A study of this county by the Ohio Department of Rural Economics shows that in addition to this amount of land on farms entirely abandoned, 20,000 acres of the farms is brush land and 6,000 acres is bare and eroding. A total of about 100,000 acres out of the county total of 260,000 is brush or waste land. This land is not producing. Some of it will quickly seed down to a reasonably good forest growth but the greater part must be planted.

Research agencies must lead the way to proper management of these three classes of land since there is no background of experience to enable the individual to plan profitable management of them.

Projects reported last year in the Station's program have occupied the time of the Station staff through the calendar year. These projects are reported in detail in this report.

#### ADMINISTRATION

##### Research Facilities

Equipment in addition to that carried over from the preceding year was purchased only when very urgently needed. One camera and a few articles of laboratory equipment were acquired. Filing cases and library units were bought as needed.

The library now includes 139 bound volumes and approximately 2000 bulletins, circulars and pamphlets.

412 photographs were taken during the year. The Station now has 519 mounted with 805 others - lantern slides 785.

The Department of Chemistry, Ohio State University, furnished the Station a laboratory and gave access to its chemical supplies for use of Dr. J. T. Auten in his study of litter.

##### Personnel

All promotions beyond those provided through the Welsh act have been financed from the regular Station appropriation. Two unfilled positions now exist in the Station staff, one of which cannot be filled until increased appropriations are available.

The Station regrets to announce the loss of Leonard I. Barrett, Assistant Silviculturist, through his transfer to the Appalachian Station. His services were lost because the Station was unable to provide an increase to meet an offer outside the service, thereby forcing his reallocation to the staff of another Station. Leonard F. Kellogg was promoted to the grade of Associate Silviculturist as of January 1, 1931 as a result of the very effective work which he has done during the three years of service with the Station.

The position formerly occupied by Ruth G. Ent has been filled by the employment of Mary Jane Nimocks as junior clerk-stenographer.

The policy followed in former years for securing services of forest school students for temporary employment during the field season was continued through 1930. A list of those employed is shown under the list of staff members.

#### Distribution of Expenditures

The distribution of work done by the Station is indicated by the percentage of the Station allotment spent on each project. Since the fiscal year begins in July the distribution of funds for the fiscal year 1930 (July 1, 1929 - June 30, 1930) is given as a whole rather than attempt a fair apportionment of the last part of that year.

<u>Project</u>	<u>Distribution of Total Expenditure of \$30,543.10 for fiscal year 1930</u>	<u>Distribution of Total Expenditure of \$18,027.70 (July 1, 1930 to December 31, 1930)</u>
	<u>Per Cent</u>	<u>Per Cent</u>
Plantation (Fp-1)	34.68	30.75
Woodland Grazing (Pa-1)	23.14	23.29
Litter (M-1)	11.35	33.60
Oak Yield (Ts-12)	15.55	9.62
Types (T-1)	3.10	2.67
Yellow Poplar (Ts-375)	4.98	.07
Management Cutting (Mc-1)	4.79	-
Management Yield (My-1)	2.41	-

#### Distribution of Field Time by States - Permanent and Temporary Staff -

Calendar Year 1930.

<u>States</u>	<u>Man Days</u>
Ohio	243
Indiana	292
Iowa	196
Illinois	124
Kentucky	21
Missouri	10
Tennessee	3
Total	889

### Working Centers

Outside of the center of work being developed at the Clark County State Forest in cooperation with the Indiana State Commission of Conservation, no other definite centers of work have been selected. This is partly due to the fact that the studies of plantations and grazing call for the visiting of isolated farm woodland tracts scattered generally through the Corn Belt region. The establishment of working centers in connection with these two projects is not feasible.

One other principal project of the Station, the study of litter in virgin forest, has also been conducted on a reconnaissance basis. No federally owned land is available to the Station except the national forest now being purchased in Kentucky and the national forest already organized in northern Arkansas.

The Station wishes to take this opportunity to announce the pressing necessity for the establishment of more working centers. Permanent work cannot be undertaken until such working centers are recognized, since the cost of carrying on remeasurements of sample areas is otherwise excessive.  
The Station wishes, therefore, to invite offers of cooperation in each of the states with a view to establishing centers of work where studies on sample areas can be carried out through a period of years. This will require a very definite understanding with the agencies controlling the land so that funds invested in studies of these areas will not be jeopardized through a change in management or purpose of the owner. Working centers will be selected as fast as active work can be done upon them and as opportunity is given for their establishment.

### Cooperation

The staff of the Station assisted in forestry instruction in the Ohio State University and took part in public meetings held during Farmers' Week. McCarthy addressed forestry students in the University of Purdue and at the Iowa State College of Agriculture. The Station took active part in directing the meeting and field trip of the Ohio Valley Section of the Society of American Foresters and in the work of the First Central States Forestry Congress.

A cooperative agreement was drawn with the Purdue Agricultural Experiment Station and under this agreement a study of the classified woodlands of Indiana was undertaken in connection with the grazing project. A further cooperative study of the carrying capacity of woodlands is planned.

## INVESTIGATIONS

### Studies in Progress

The work of the Station for the year was largely a continuation of the major projects initiated previously. In addition to studies of older plantations, grazing in relation to woodlands, one new major project was initiated to cover the study of litter in virgin woods. The purpose of this study is to begin the collection of information in regard to soil conditions which influence the growth and life history of the forest. It was thought logical to start this work by study of the litter and humus zone as found in virgin conditions.

### Fp-1 Plantation Study

The year's work was planned to finish the examination of plantations in the Central States region in such a way that sufficient data would be on hand to allow the production of a first report. The work was focused on plantation black walnut because of the frequency with which early tree planters used this species. Data secured in the two preceding seasons were supplemented and filled out in order to complete the field work on walnut, and compilation work was designed to prepare a report on the yield in plantations for this species.

### Field Work

Two crews were used. One, composed of Albert F. Dodge and Karl F. Thielking, students from the School of Forestry, Iowa State College, Ames, Iowa, started work on the 20th of June at Iowa City, Iowa. A second crew, composed of Ben Lucas, a student from Pennsylvania State College and Robert O. Sowash, a forestry student from Michigan State College, began their field work on the first of July and left the plantation project on the 15th of August to carry out other project work for the Station in southern Indiana. Dodge departed for school on September 16th and Thielking remained until September 20th.

The territory covered during the season consisted of Iowa, central and northern Illinois and a few scattered portions in northern Missouri. Previous field work had been done in Illinois, and that done in 1930 supplemented former efforts. During the collection of stem measurements for volume table purposes in 1929, inspection of all black walnut plantations was made to determine their suitability for yield plot purposes. These notes allowed the crews to visit only those plantations which were valuable for the purposes of the study and prevented a great deal of nonproductive travel. A good many additional plantations were found by both parties, however, and such unknown stands very materially added to the sampling of walnut plantations.

The major aim of the field season was to measure plots in all possible stands, in order to fill the gaps in the height-age distribution records previously made. It was desired especially to secure plots in stands older than 60 years and under 30 years of age and also those on exceptionally poor sites. Consequently the major portion of the field

work was directed towards the securing of plot measurements. Because of the economic depression very few walnut concerns were manufacturing walnut lumber and veneer and consequently very little cutting was going on in any plantings. For this reason no opportunity was met to secure additional measurements on the sapwood-heartwood content of black walnut trees.

Whenever opportunity was found, certain plots taken in 1928 were revisited and maps were prepared of them in order to complete the data on such plots.

In August, thinning operations were carried on in the test plantings at the Arboretum of the Ohio Agricultural Experiment Station at Wooster, Ohio. L. I. Barrett and R. F. Bower, Assistant Forester at the Ohio Agricultural Experiment Station, removed trees in several of the coniferous plantations and stem measurements were taken on these trees.

TABLE I

Plantation Stem Measurements  
Ohio Agricultural Experiment Station, Wooster, Ohio

D.B.H. Class -Inches-	Stems Measured - by Species			
	Red Pine	Scotch Pine	Corsican Pine	Norway Spruce
-No.-	-No.-	-No.-	-No.-	-No.-
1	18	-	-	-
2	70	3	2	1
3	66	10	3	6
4	11	6	-	6
5	8	4	-	6
6	7	-	-	1
7	-	1	-	-
Total	180	24	5	20

The stands in which these measurements were taken are mostly 20 years old and are spaced at different intervals. Bark thicknesses were measured and diameters were taken at 1.0, 2.5 and 4.5 feet above the ground, and then at 10 per cent intervals thereafter.

Another feature of the summer's field work was an effort to secure a moderately close estimate of the annual cut of plantation black walnut. A visit was made to Mr. George M. Lamb, formerly Secretary, American Walnut Manufacturers Association, Chicago, Illinois to inquire regarding the annual cut of black walnut from planted groves. Acting upon his suggestion Kellogg made contact with several of the members of the Association and inquired of them regarding the origin and sources of their annual cut.

Following are a list of the producers who were visited:

Ponrod, Jurden and Clark	Des Moines, Iowa
Ponrod, Jurden and Clark	Kansas City, Mo.
Frank Purcell Walnut Lbr. Co.	Kansas City, Kans.
Shanklin Walnut Lbr. Co.	Kansas City, Kans.
Pierson-Hollowell Lbr. Co.	Danville, Ill.
A. T. Foley Lbr. Co.	Paris, Ill.
Pickrell Walnut Lbr. Co.	St. Louis, Mo.
W.L. Fletcher, Representing Nickey Brothers,	
2700 Summit St.,	Memphis, Tenn.

Several of these concerns had a very definite knowledge regarding the source of their material, and some of them declined to comment on the source of their logs. As a result only an approximate idea of the amount of plantation walnut can be secured. The returns which walnut manufacturers make to the Census give no possible clew to the amounts of plantation and native walnut which are cut.

#### Office Work

Black Walnut Volume Tables - The 400 stem measurements which were secured in 1929 have been compiled into volume table form, and a portion of the tables are finished and are now available. The checking of the plotted points on each graph to detect errors made in the field, and the drawing of curves through these points were completed by March, 1930. The Office of Forest Measurements in Washington, D. C. then undertook the task of planimetering and scaling these stem measurements and the construction of volume tables from them. The following tables have been completed: (1) Total cubic feet, entire stem, less bark, 1.0 foot stump, merchantable cubic feet, with bark, to the top O.B. diameter of 4.0", 1.0 foot stump; (2) International board feet, 1/8" kerf to a 5.0" top D. I. B., scaled in 12-foot log lengths. Other tables which are being constructed are Scribner D.C. to an 8.0" top, scaled in 12-foot logs. Scribner D.C. to a 10.0" top, scaled in 12-foot logs. The completion of these tables finishes the first step in the study of yield, and allows the computation of volume on the yield plot records.

Map Records - Records of plot and plantation locations have been kept on county maps gathered in the course of the field work by the chiefs of parties and the project leader. These maps have been checked over and have been completed for the states of Indiana and Illinois. Reference to them allows an instantaneous impression of the distribution of black walnut and other plantations within a given county. A card record is in progress of being completed, giving brief notes on many plantations which were understocked, altered, and unsuitable for the purposes of this study. This card record ties each plantation into nearby towns to allow subsequent revisititation for this or other project purposes. In connection with a paper delivered at the first Central States Forestry Congress, a map has been prepared showing the location of the 550 black walnut plantations which have been visited and inspected in connection with this project.

This map presents in a clear way the localized distribution of black walnut plantations.

During the autumn, references were secured on the location of perhaps 8 or 10 black walnut plantations in Ohio. This information was secured after the departure of field assistants, and consequently it was too late to inspect and take yield plots in suitably stocked Ohio stands for this study.

Data on Hand - During the field season 129 yield plots were measured. By far the largest proportion of these were in stands of black walnut because the field work for this project was planned to give particular attention to this species. However, an exceptional black cherry planting was found and circumstances favored the measurement of plots in several other species as will be noted in Table 2.

TABLE 2

Statement of Plantation Plot Work  
Season of 1930

Species	Plots :		Spread of Age	Spread of Dom. Hts.	State
	-No.-	-Yrs.-	-Foot-	-Foot-	
Butternut	1	36	38	Iowa	
Cherry, black	1	34	43	"	
Hickory, shagbark	1	48	58	Illinois	
Maple, silver	1	47	75	Iowa	
Mixed hwdws.	3	28-38	37-50	Ia.-2, Ind.-1	
Pine, white	1	39	48	Iowa	
Pine, Scotch	1	2	-	Ohio	
Poplar, yellow	2	8	4	Illinois	
Walnut, black	119	8-71	11-85	Ill.-28, Ind.-1 Ia.-89, Mo.-1	
Total	129	-	-		

By far the largest proportion of the plantation measurement work during the past three years has been in the states of Illinois and Iowa. Reference to Table 3 will show the states covered in this project and the number of plots which have been taken in each state. Had there been available more plantations in such states as Kentucky and Missouri, more equitable distribution of time would have been possible.

TABLE 3

Summary  
Plantation Plot Work - by States  
Season of 1930

State	1928	1929	1930	Total
	-No.-	-No.-	-No.-	-No.-
Illinois	10	85	31	126
Indiana	39	15	1	55
Iowa	-	-	95	95
Kentucky	-	17	-	17
Missouri	-	-	1	1
Ohio	-	-	1	1
Total	49	117	129	295

A summary of walnut plots which have been taken according to state, shows the largest number to have been taken in Illinois, nearly an equal number in Iowa, a smaller number in Indiana followed by a few in Kentucky and one in Missouri. Without doubt, Missouri has many more walnut plantations in it north of the Missouri River, than this Station has been able to discover without incurring excessive expense. No records appear to be available for this portion of the state and the only way to locate such plantings as very likely exist, is to cruise the country. Because of their relative infrequency, it was considered doubtful economy to do this.

TABLE 4

Plantation Black Walnut Plots  
By States - 1928-1930

State	No. of Plots
Illinois	90
Indiana	28
Iowa	89
Kentucky	8
Missouri	1
Total	216

Rodent Damage to Scotch Pine

Prior to the opening of the field season considerable rodent damage was noted by Barrett and McCarthy in a new Scotch pine plantation near Columbus, Ohio. A permanent sample plot was placed in this planting to study the character of injury which had been done and to follow the growth and development of this stand of Scotch pine. It was found that because of the high population of rabbits on this particular property, 50 per cent of the trees had been damaged in varying amount. The following table shows the character and proportion of the trees which had been injured.

TABLE 5

Rabbit Damage to Scotch Pine  
 Boy Scout Camp  
 Columbus, Ohio  
 1 year old

<u>Character of Damage</u>	<u>Trees Showing Damage*</u>	
	<u>Number</u>	<u>Per Cent</u>
Gnawing of Main Stem	2	1.0
Cutting of Main Stem	9	4.5
Buds eaten partly or wholly	19	9.5
Needles eaten partly or wholly	25	12.5
Cutting of side limbs	85	42.5

\* Basis 200 trees on 1/5 acre plot.

The average height of all trees in 1929 when the plantation was established was found to be 1.08 feet and the average height of all trees in 1930 was found to be 1.44 feet. On an average the trees were found to have grown 0.36 feet during 1929. About 82 per cent of the pines were found to have a single leader and the rest varied from having no leader at all to as many as nine.

#### Remeasurement of Sprouting of Planted Yellow Poplar

During the latter part of April, Doctor Auten assisted Kellogg in remeasuring the plot in Hay Hollow, Pike County, Ohio, established to trace the sprouting of yellow poplar and to collect data on the growth of this species when planted on old fields. It was found that during 1929 on an average, the poplar grew 0.4 of a foot. To date 19 per cent of the yellow poplar trees show basal sprouts and it was found that a larger proportion of seedlings show sprouts than those where limbs have become leaders and others which can be classified as seedling sprouts. Height growth varied from 0.0 to 1.8 feet for the year. An analysis of the trees which had produced sprouts showed that on an average such trees grew only 0.2 of a foot in 1929 and the average height growth of the sprouts was 1.7 feet.

#### Planted Yellow Poplar vs. Burned Sprout Hardwoods

In order to test the feasibility of planting yellow poplar on land from which the native scrubby growth had been cleared and then burned, the Mead Pulp and Paper Company of Chillicothe, Ohio established such an area in April, 1928 in Hay Hollow, a few miles from town. Measurements have been made on the sprout growth which appeared following a clean burn of the area and immediate planting to yellow poplar. It was found that the sprouting of existing tree root systems and stumps was exceedingly vigorous and that under conditions on this area, sprouting was more vigorous after burning than that after clearing, due to two years of vigorous sprout growth before burning.

In August, 1930 a careful search showed 55 live yellow poplars out of about 500 which had been planted on the sample half acre. Seven others were found to have died during the summer. The 55 live trees averaged 2.1 feet in height and their future is not hopeful. Under conditions on this plot, it was found entirely impractical to convert young forest cover to yellow poplar or to introduce yellow poplar into the existing forest type by clearing, burning and then planting. The extremely rapid growth of sprouts following the fire shaded out the planted yellow poplar and eliminated it.

#### Photographs

As in previous seasons, a Station camera was assigned to the plantation project and was used through the season to secure photographs of plantation and other forest subjects. A very considerable proportion of pictures taken were concerned with black walnut but a variety of other subjects was covered. The following table briefly reviews the number and character of photographs which have been added to the Station collection from 1930 field work.

TABLE 6

Summary of Photographic Work  
Plantation Project  
Field Season - 1930

Subject	Number of Views
<u>Plantations</u>	
Ash, green	1
Butternut	1
Catalpa	2
Catalpa & yellow poplar seeded in	1
Cherry, black	1
Chestnut	2
Cottonwood	2
Locust, bl. and yellow poplar seeded in	1
Maple, silver	2
Oak, red	2
Oak, white	1
Pine, Scotch	1
Pine, White	2
Poplar, yellow	11
Hickory, shagbark	1
Walnut, black	69
Mixed	1
<u>Damage</u>	
Fire	3
Grazing	11
Iron	3
Rabbit	4
<u>Dune Control</u>	
Erosion control (Catalpa)	2
Litter	2
Measurements	3
Tree Planter	2
Old Uses of Wood	2
Soil	5
Utilization	11
Timber Types	13
Miscellaneous	19
<b>Total</b>	<b>183</b>

General

Over sixty per cent of the area covered by the Central States Forest Experiment Station lies within the area of the Wisconsin and Illinoian glaciation. Within this area of glacial soils, more than eighty-five per cent of the land is in farms and the forest problems are accordingly farm woodlot problems. Grazing has long been known to be the most important factor in the steady deterioration of the woodlands of this agricultural belt, and the possible solution of this problem was recognized as the first step toward developing plans for the rehabilitation of these areas. Consequently a study of the relation of grazing to the farmwoods was set up as one of the first major projects of the Station.

The annual report on this project for the year 1929, covered the results of the general reconnaissance survey made during 1928 and 1929 by Meyer and Day, and made specific recommendations for the future conduct of the study. The work proposed for the field season of 1930 was a study of a number of woodlands previously grazed but now protected from livestock, and an extension of the reconnaissance study in Indiana and Ohio to secure data in the beech-maple type comparable to the data previously secured in the oak-hickory type.

Both of these objectives were accomplished during the field season and it is believed that sufficient data have been secured to fulfill the purposes of the empirical study and that further work will be confined to intensive study of permanent sample plots. In the three seasons during which this study has been carried on, 208 semi-permanent plots have been located and measured. Over 1800 farmwoods have been examined in the eight states comprising the territory of this Station. Dr. Meyer, to whom the project was originally assigned, located fifty three of these plots in Indiana and Illinois during the summer of 1928. In the field season of 1929 Day covered the remainder of the region, with the exception of Ohio, in a rapid field reconnaissance and located and measured seventy four additional plots. During the past summer, Day with DenUyl of the Purdue Agricultural Experiment Station measured sixty plots in the classified woods of Indiana, and Day, in addition, secured seventeen plots in Ohio. The distribution of these plots is shown in the following table:

TABLE I  
Distribution of Semi-Permanent Grazing Plots

State	Grazed in Past			Total
	Grazed	Ungrazed	Ungrazed at Present	
Ohio	14	9	5	28
Indiana	17	16	60	93
Illinois	15	5	4	24
Iowa	11	5	5	21
Missouri	8	2	3	13
Arkansas	4	3	-	7
Kentucky	7	5	-	12
Tennessee	3	3	-	6
Total	79	48	77	204

The field work during the past season was divided into two phases. The first consisted of an examination of a large number of woodlots in northern and north central Indiana which had been classified under the Indiana tax law. These areas were examined for the purpose of locating tracts which had had a definite grazing history prior to their classification and the removal of the livestock. About sixty such areas were located and semi-permanent plots established and measured to determine the rate and degree of recovery from the effects of the previous grazing. This phase of the summer's work was conducted in cooperation with the Forestry Department of the Purdue Agricultural Experiment Station. Work was initiated on June 20th; Ralph K. Day of this Station and Daniel DenUyl of the Purdue Station directing the study, and two students, M. C. Smith and H. M. Benedict assisting.

The second phase of the season's work consisted of an extension of the reconnaissance study of 1928 and 1929 to portions of Indiana and Ohio for the purpose of securing data on the beech-maple type comparable to that secured for the oak-hickory type. This work was carried on during the last half of August and the first half of September by Day, Smith and Keefus. Keefus, a junior from the forest school at Purdue, was transferred to the grazing project from Dr. Auten's party on August 1st. Three other temporary assistants, Huberman, Lucas and Sowash were assigned for short periods to the grazing party.

Active field work was terminated on September 20th and with the exception of several short field trips in connection with proposed permanent sample plot studies and other administrative duties, the remainder of the calendar year was devoted to office work.

#### The Reconnaissance Phase

The purpose of the reconnaissance study carried on during the field season of 1928 and 1929 was to make a general survey of the entire Central States region with the view of determining where the grazing problem was most severe, what particular phases of the problem should receive intensive study, and to gather data on the more direct effects of grazing livestock in the farmwoods. The first two subjects were covered at considerable length in the annual report for 1930. Compilation and analysis of the quantitative data secured from the sample plots has been delayed through lack of clerical assistance and the absence of comparable data on the beech-maple type in Ohio and Indiana. This data was secured during the past season and this phase of the problem will be pushed to completion as rapidly as is possible with the limited computing assistance available.

It is possible from the work already accomplished to draw a number of general conclusions which are not dependent upon the quantitative data secured. These may be briefly summarized here.

1. The grazing of livestock was found to be a factor in the unproductive conditions of the farmwoods throughout the entire Central States region.

2. A close correlation was found to exist between the rich agricultural sections, and the areas where the degree of damage by grazing to the farmwoods was most severe.

3. The damage to farmwoods by grazing was found to be most severe in the states of Ohio, Indiana, Illinois, and Iowa, and within these states it is chiefly limited to the glacial soils of the Wisconsin and Illinoian drift areas, the "Corn Belt."

4. Within this glaciated section over ninety per cent of the farmwoods are being grazed more or less continuously; the ungrazed woodlot usually is the result of accident rather than intention.

5. A combination of economic factors have resulted in this high percentage of woodland grazing; the farmers of the Corn Belt region are practically forced to use their woodland for pasture purposes.

6. These woodland pastures are being grazed to the extent of at least five times the carrying capacity of the herbaceous and shrubby vegetation which they support.

7. The principal effect of this overgrazing on the woodlot is the retardation, deformation, and usually complete elimination of reproduction between the height of six inches and twelve feet.

8. This constant destruction of reproduction, combined with the death and occasional cutting of mature timber, is rapidly converting the woodlands of the better agricultural sections of the Central States into open pastures.

9. The final cleaning up of these remnant woodlots is almost entirely responsible for the alarming decrease in the area of farmwoods in the Central States region.

10. According to the Census records for the entire Central States region, this decrease amounted to over five million acres between the years of 1920 and 1925. In the Corn Belt alone the loss was over three million acres.

11. Continuous efforts on the part of the various forestry agencies of the Corn Belt states have accomplished little toward the permanent removal of livestock from the woodlands.

#### Study of the Classified Woods of Indiana

The general report of the reconnaissance phase of the study given in the 1930 annual report, specifically recommended that a study of the recovery of farmwoods following the exclusion of livestock, should be one

of the first steps in the future conduct of the project. An excellent opportunity for securing the field data on this phase was offered by the large number of woodlands which have been classified under the Indiana tax exemption law. This law, which has been in effect since 1921, provides for the taxing of woodlands, which meet certain requirements, on an appraisal valuation of one dollar per acre.

The exclusion of livestock is the most important of these requirements, and in keeping with the law, many areas, previously grazed, have been fenced against stock for periods of one to ten or more years.

This study was carried out in cooperation with the Purdue Agricultural Experiment Station and the State Forester of Indiana. The state forester furnished the list of classified owners and much valuable information concerning the history of the areas. The Purdue Agricultural Experiment Station furnished one man from its staff, who worked with Day during the months of June and July and is assisting in the compilation and analysis of the data, and collaborating in the preparation of a bulletin covering this study. This bulletin will be published by the Purdue Agricultural Experiment Station.

The field methods used in the study were essentially the same as those used in gathering the data for the reconnaissance phase of the project.

Rather rigid requirements were set up in selecting woodlands for examination, the chief object being to secure areas which would be comparable and in which the elimination of grazing had been the only important factor involved. Semi-permanent plots of from one quarter to one acre in area were established in those woods which met these specifications. These areas were definitely marked with iron stakes for possible future use.

The standing timber above 0.5" D.B.H. on the plot was then tallied by species, diameter, and crown classes. Two transects were laid out at right angles to the longest dimension of the plot and spaced so as to divide the tract in three equal parts. Reproduction was recorded on a strip 6.6 feet wide along these transects. The young growth below 0.5" D.B.H. was tallied by species, height and origin (sprout or seedling). Rather complete notes were taken on the vegetative cover together with the usual descriptive notes. All photographs were referenced to definitely located points for possible future use.

The quantitative data secured in this study is now being analyzed and it is believed that the publication will be ready for the printer by June 1st. The result should show much valuable information on the ability of native woodlands to recover from the effects of the various intensities of grazing.

Permanent Sample Plots

Progress on the establishment of permanent sample plots has of necessity been slow. Experimental work, involving the use of carefully controlled areas over a period of years, is expensive, and the initiation of such experiments should accordingly be done only after careful and complete consideration. Because of the nature of the project, many of the permanent sample plots will have to be established on private lands. This will necessitate extreme care in preventing excessive loss of time, money and effort through instability of ownership. Selection of plots must also be governed as far as practical by consideration of economy in travel and with reference to definite working centers.

It is believed that conditions common to the entire Corn Belt can be found in Ohio, Indiana and Illinois, and it is proposed to confine all permanent sample plot work on this project to these three states at the present time. With this idea in mind, a number of areas were examined during the first year and about fifteen found satisfactory for use and the coming field season will probably be largely devoted to the establishment of a number of such areas. The areas which have been tentatively selected for establishment are as follows:

TABLE 2

Permanent Sample Plots to be Established

Perm. sample lot #	Owner	Location	Type	Size of Plot	Primary Purpose of Plot
1	Purdue Univ.	LaPorte Co., Ind.	Oak-Hickory	6A.	Determination of carrying capacity of farmwoods.
2	" "	" " "	" "	12A.	" " "
3	" "	" " "	" "	18A.	" " "
4	Marion Casebeer	Cass Co., Ind.	" "	1A.	Effect of breaking up sod cover in establishment of reproduction.
5	" "	" " "	" "	1A.	Check plot for No. 4
6	" "	" " "	Upland Sw.	$\frac{1}{4}$ A.	Recovery of farmwoods following exclusion of livestock.
7	" "	" " "	" "	$\frac{1}{4}$ A.	Check plot for No. 6 (grazing continuous)
8	" "	" " "	Beech-Maple	$\frac{1}{4}$ A.	Recovery of farmwoods following exclusion of livestock. 70% stocked.
9	" "	" " "	Oak-Hickory	$\frac{1}{4}$ A.	Recovery of farmwoods following exclusion of livestock. 80% stocked.
10	O. E. Pell	Clay Co., Ind.	Upland Sw.	$\frac{1}{4}$ A.	Recovery of farmwoods following exclusion of livestock. Classified 1925. 30% stocked.
11	" " "	" " "	" "	$\frac{1}{4}$ A.	Ditto. Classified 1929. 40% stocked.

TABLE 2 - Cont'd.

## Permanent Sample Plots to be Established

Perm. Sample Plot #	Owner	Location	Type	Size of Plot	Primary Purpose of Plot
12	O. E. Pell	Clay Co., Ind.	Oak-Hickory	$\frac{1}{2}$ A.	Check plot for No. 10-11 (grazing continuous)
13	Emerson	Steuben Co., Ind.	" "	$\frac{1}{2}$ A.	Rate of growth on grazed plot (Paired with No. 14 which is ungrazed) north slope.
14	"	" "	" "	$\frac{1}{2}$ A.	Ditto except ungrazed. Paired with No. 13
15	"	" "	" "	$\frac{1}{2}$ A.	Rate of growth on grazed plot, south slope. Paired with No. 16.
16	"	" "	" "	$\frac{1}{2}$ A.	Rate of growth on ungrazed plot. South slope. Paired with No. 15.
17	Haskins	St. Joseph Co., Ind.	Beech-Maple	$\frac{1}{2}$ A.	Regeneration of woodlands following exclusion of livestock. 30% stocked.
18	"	" "	" "	$\frac{1}{2}$ A.	Regeneration of woodlands following exclusion of livestock. 40% stocked.
19	"	" "	" "	$\frac{1}{2}$ A.	Check plot for 17 and 18. Grazing continuous.
20	John Lindimere	Lake Co., Ind.	Oak-Hickory	$\frac{1}{10}$ A.	Regeneration of farm woodlands. 80% stocked.
21	" "	" "	" "	$\frac{1}{10}$ A.	Check plot for No. 20.
22	McVickers	Grant Co., Ind.	Beech-Maple	$\frac{1}{2}$ A.	Regeneration of farm woods. 50% stocked.
23	"	" "	" "	$\frac{1}{2}$ A.	Rate of growth on grazed and ungrazed plots. Grazed plot paired w. 24.
24	"	" "	" "	$\frac{1}{2}$ A.	Ditto. Ungrazed plot. Paired with No. 23.
25	I. Sweigert	Miami Co., Ind.	Oak-Hickory	$\frac{1}{2}$ A.	Regeneration of farm woods. 80% stocked.
26	" "	" "	" "	$\frac{1}{2}$ A.	Ditto. 70% stocked.
27	" "	" "	" "	$\frac{1}{2}$ A.	Ditto. 60% stocked.

Pinney-Purdue Phase

One of the most important problems which was brought out by the reconnaissance survey was the necessity for the determination of the actual carrying capacity of farmwoods. This problem is one on which practically no work has been accomplished in this region. The determination of the amount of farmwoods necessary to support an animal unit in

the various timber types and degrees of crown density, is particularly desirable in supporting the belief of foresters that the grazing value of these areas is practically nil.

In connection with the study of the classified woodlands of Indiana, the Pinney-Purdue farm in northern Indiana was visited. This area is owned by the Purdue Agricultural Experiment Station as an experimental farm. There is located on this farm a tract of oak-hickory woods typical of farm woods throughout this region. It has been grazed more or less continuously and represents conditions common to overgrazed woods through the Central States. These woods were examined and found to be admirably suited for a study of the stock carrying capacity of such an area of woods. The area was again visited in October by Day and DenUyl and tentative plans laid for the initiation of such a project. Conferences were also held at Lafayette with the Superintendent of the state farm and the head of the Animal Husbandry Department. They both expressed their interest and willingness to cooperate in this study. The primary purpose of this proposed study is to determine the actual number of acres of a typical farmwoods required for adequate support of one cow unit. Secondary purposes of the study are:

1. To work out a technique for similar experiments in other forest types and under other degrees of crown density.
2. To make an intensive study by the use of quadrats of the degree of utilization and the palatability of the grass, herbaceous and shrubby vegetation of the woodlot.
3. To make an intensive study under controlled conditions of the various forms of injury to the standing timber, tree production and the soil.

Further plans are covered in the program for 1931.

### Ts-12 Oak Study

Measurements made in the study of yield of second growth oak were assembled by Barrett and transmitted to Washington for computation. No active field work was done on this phase of the project during the year.

An area of about 163 acres on the Clark County State Forest in southern Indiana was selected for the study of yield on a permanent plot basis. Trees on 10 per cent of this area were tagged and measurements of diameter and height were made at the time of plot establishment. Records were also taken on the amount of timber cut in the last logging operation in 1929. This sample area will be remeasured at intervals of five years to determine growth rate.

Barrett also followed through the chestnut oak regeneration plots established in the previous year to determine the amount of mortality in seedlings. It is the purpose of the Station to follow these plots which have received several types of treatment to determine the best method of cutting for promotion of growth in chestnut oak seedlings.

### T-1 Forest Types

In cooperation with a committee on forest types of the Society of American Foresters, McCarthy listed and described the types for the Central States region, submitted them for the criticism of the Ohio Valley Section at its annual meeting and met with the forest types national committee at the annual meeting of the Society in Washington at the end of the year. The final report of the forest types committee for the eastern United States will be made following the coming summer season. The forest types project will be retained in the program of the Station during this period.

### Erosion

The subject of erosion was given attention at the first meeting of the Central States Forestry Congress where its importance in this region was recognized both in the discussion and resolutions of the Congress. Thus far no special funds for the study of erosion have been provided to the Station for further work on this project.

### M-1 Private Forestry

McCarthy served as a member of the national committee reporting on private commercial forestry practices in the United States. This committee made its report at the meeting of the Society of American Foresters in Washington in December.

## M-1 Study of Forest Litter

The initial work on the M-1 project, inaugurated during the year 1930, consisted of a rather extensive reconnaissance during the summer season together with the completion of a soils specific gravity study and the continuance of a branch of the project in a study of the calcium magnesium content of virgin forest litter.

In planning this litter study, it was deemed advisable to approach it from the standpoint of virgin forest conditions. Obviously if knowledge is to be gained of those litter and soil conditions optimum for growth of forest trees, studies must be made in the field where undisturbed forest conditions are to be found. It is quite evident that this requires study in virgin stands. Here an equilibrium has been established through long periods of time and the best species have been selected through competition. Reforestation of the vast acreage of abandoned and cutover lands in this region must be based upon those conditions of soil under which the particular species will succeed.

With this idea in mind a trip was made through Ohio, Indiana and Illinois, for the purpose of locating and studying virgin forest sites. To one unfamiliar with the territory, this might seem an easy task, but as a matter of fact, virgin forest sites in the Central States are practically non-existent. There are many areas in this region whose soil has been sufficiently undisturbed to be suitable for a study of the nature contemplated but on most of these the forest has been disturbed by cutting, fire, and grazing. As a result of extensive travel during the summer of 1930, about three virgin sites were located in the state of Ohio, one or two in Indiana and two in Illinois.

A few points were brought out rather clearly during this reconnaissance trip. One in particular, which has been submitted for publication, was the observation of the difference in porosity between the virgin forest soil and the adjacent cultivated soil. As a result of over four hundred apparent specific gravity tests in eighteen stands over the states of Ohio, Indiana and Illinois, it was very conclusively shown that forest soil has greater porosity than cultivated soil. This is a very important finding, not only from the standpoint of plant growth and general soil tilth, but also from the very important standpoint of water-holding capacity. At the present time a study is being made of the calcium and magnesium content of virgin forest litter and of the soil profile under the virgin forest. It seems quite probable that the presence or absence of the alkaline earth metals in the surface horizons of forest soils may have a very important role, not only in plant nutrition but in biological relationships.

## PROGRAM FOR 1930

### General

Activities of the Station for 1931 will be largely a continuation of the projects already under way. In the study of plantations a new phase will be undertaken in the study of yield in black locust. In the grazing project attention will be given to the carrying capacity of woodlots in terms of the number of acres required to support one head of stock. Permanent plots will also be established for the determination of certain influences which cannot be worked out on an extensive basis. The study of yield tables for second growth oak will be completed. The examination of litter will be continued to determine its influence upon the porosity of soil in other types of woodland and the relation of calcium content to acidity.

### Fp-1 Plantation Study

Through the assistance furnished by the Section of Computing in Washington, it is expected that yield tables for plantation grown black walnut will be completed, thereby enabling Kellogg to complete his manuscript on plantation grown black walnut during the current year. Kellogg will undertake a study of yield in plantation grown black locust for which he has already located one hundred or more suitable plantations. This species has been widely planted especially for post production purposes and is a valuable tree in farm regions. The chief drawback thus far has been the attack of the locust borer and the Station is fortunate this year in having the cooperation of the Division of Forest Entomology of the Bureau of Entomology in Washington. A man will be assigned by this Division with headquarters at the Central States Station to undertake the study of the locust borer in the Central States region.

The success of the entomological study in discovering control methods for this insect will greatly affect the subsequent development of locust plantations.

In initiating this study of the black locust, it is the intention of the Station to conduct not only studies of yield but also studies of insect damage and the relation of nitrifying bacteria to the growth of this species. This combination of studies will enable this Station to conduct its field work in all three phases to much greater advantage than if the work were done independently. Correlation of the findings in these three phases may result favorably in the solution of the insect problem. The Bureau of Entomology of the Ohio State University and several state entomologists have already indicated their desire to cooperate actively in this work. A graduate student of Ohio State University has indicated his desire to undertake the study of the influence of nitrifying bacteria on the growth of locust. There is also good probability that the locust tree has an important function in the fixation of nitrogen for the benefit of other species planted in association with it. Two field parties will undertake work in connection with this project.

In initiating this study of the black locust, it is the intention of the Station to conduct not only studies of yield but also studies of insect damage and the relation of nitrifying bacteria to the growth of this species. This combination of studies will enable this Station to conduct its field work in all three phases to much greater advantage than if the work were done independently. Correlation of the findings in these three phases may result favorably in the solution of the insect problem. The Bureau of Entomology of the Ohio State University and several state entomologists have already indicated their desire to cooperate actively in this work. A graduate student of Ohio State University has indicated his desire to undertake the study of the influence of nitrifying bacteria on the growth of locust. There is also good probability that the locust tree has an important function in the fixation of nitrogen for the benefit of other species planted in association with it. Two field parties will undertake work in connection with this project.

#### Pa-1 Relation of Grazing to the Farmwoods

##### General

During the two and a half years in which this project has been in progress, the work has largely been of an extensive nature. While considerable data has been collected it is evident that much work remains to be accomplished. Most of the problems upon which additional work will be necessary are of such a nature as to require intensive work over a period of years on carefully controlled areas. It is obvious, therefore, that the future development of this project will be largely through the establishment and periodic remeasurement of permanent sample plots.

As indicated in the Annual Report, the project is definitely assuming several distinct phases, each of which will require a more or less different approach in their solution. It seems desirable, therefore, to treat these separate phases as subdivisions of the major project.

These five phases which have been recognized and which will be hereafter treated as separate subdivisions of the major project are:

1. The Reconnaissance Phase.
2. The Reconstruction Phase.
3. The Livestock Management Phase.
4. The Growth and Yield Phase.
5. The Economic Phase.

Cooperative studies or studies involving a considerable amount of field work in connection with any one of the above phases, will be planned independently. Plans for the field season of 1931 contemplate the employment of a crew of two men who will be engaged largely in the establishment of permanent sample plots, especially in connection with phases 2, 3 and 4.

### Reconnaissance Phase

The field work on this phase is complete. The plans for this year are to complete the compilation and analysis of the sample plot data and to prepare a bulletin on this phase of the problem. This will probably be a Farmers' Bulletin or Miscellaneous Circular of the Department covering, "The Effect of Grazing on the Reproduction in the Farmwoods of the Central States." The time of completion of this phase depends largely upon the amount of computing assistance that can be secured. As much time as can be spared from necessary supervision of field parties during the field season, will be devoted to the completion of this phase.

### Reconstruction Phase

This phase of the study has been set up as a separate subdivision of the project. The analysis of the data gathered from the study of the classified woodlots of Indiana during the summer of 1930 will be completed during the early part of the year and a bulletin prepared covering the results of this study. This bulletin will be published by the Purdue Agricultural Experiment Station as the first of a series of cooperative studies between the two Stations.

A working plan outlining the future development of this phase of the project will be prepared prior to the opening of the field season. During the summer a number of permanent sample plots will be established to permit periodic remeasurements following the regeneration of these areas. A minimum of four plots in each of the three broad regional types will ultimately be established. These areas have been tentatively selected from the semi-permanent plots established last year and are listed in the first section of this report.

### Livestock Management Phase

This phase of the study was set up to provide information in regard to the effect of woodland pasture on livestock, the number of acres of woodland necessary to support an animal unit without damage to the timber producing capacity of the area, and also to investigate possible methods of livestock management in the farmwoods compatible with the production of timber. A working plan outlining the future development of this phase and its relation to the major project, will be prepared prior to the opening of the field season.

The first study which will be initiated under this phase is the Pinney Purdue Study. The woodlot will be divided into three fenced tracts of six, twelve, and eighteen acres each. Each of these tracts will be stocked during a six month grazing period with three head of yearling steers. These animals will receive no supplementary feeding above what they can forage from the vegetation of the tract. The stock will be weighed once a month to determine gain or loss. Two successive months showing no gain or loss for all three animals in any one tract will be considered sufficient to have shown the inability of that tract to carry that intensity of grazing.

A minimum of six quadrats will be laid out in each tract for the purpose of studying the effect of the various intensities of grazing, on the degree of utilization of the vegetation, the kind and extent of damage to the reproduction and physical character of the soil. Three of these plots in each tract will be used as a check and fenced against stock.

This project will involve the cooperation of the Forestry Department, the Animal Husbandry Department and the Superintendent of Farms of the Purdue Agricultural Experiment Station. The Superintendent of Farms will provide the livestock, supervise the care and weighing of the animals and construct the greater portion of the fencing which will be required. The establishment and measurement of the quadrats and the compilation of the publication of results will be handled by Day and DenUyl. The study will be carried on over a period of at least three years. Certain information which will be secured from the study of the quadrats to be established in connection with this study will be of value to the Reconstruction Phase. Preliminary work in connection with the initiation of this study will necessitate about three weeks field work prior to April 1, the date set for turning the cattle into the woodlot. Several inspection trips are planned during the course of the six month grazing period, followed by a detailed study of the plots and quadrats following the removal of the livestock on October 31.

#### Growth and Yield Phase

This phase is set up for the purpose of determining the effect of grazing on the growth and yield of the farmwoods beyond the reproduction stage. Preliminary studies made in connection with the Reconnoissance Phase indicated that the logical approach to this problem was through comparative studies on grazed and ungrazed areas, through periodic remeasurement of permanent sample plots, especially paired areas.

A working plan outlining the future development of this phase of the project will be prepared prior to the opening of the field season. During the coming field season a number of such permanent sample plots will be established. A minimum of four plots in each of the broad regional types will ultimately be established. Several of these areas have been tentatively selected from among the semi-permanent plots taken during the past two years and this series of plots will be completed this year if possible. Satisfactory conditions as to stability of ownership and control are rather difficult to secure in this region of high tenant occupancy with the result that permanent sample plot establishment must proceed with caution to prevent serious lost effort.

#### Economic Phase

The necessity for an intensive study of the economic phases of the grazing problem was brought out in the annual report for 1929. The need for accurate quantitative data on the relative financial returns to be expected from grazing and timber production was rather clearly indicated as the basis for an adequate appraisal of the value of any individual woodlot. The progressive farmer is going to demand such an appraisal before he makes any material investment in time or money in an effort to rehabilitate his woodland.

A working plan outlining a tentative development will be prepared during the year but no field or office work is planned on this phase for the present. It is planned to make this study in cooperation with the Forest Survey of this region. Any data having a bearing on this phase of the project which can be collected in connection with the other phases, will be filed, pending the initiation of the study.

This is an important phase and is being neglected at this time solely because of lack of funds and personnel to undertake the extensive economic research in both field and compilative work which it will necessitate.

The necessity for the early initiation of work on the Forest Survey in this region is justified by a number of economic problems and this question of grazing versus timber production in the farmwoods is by no means of minus importance.

#### M-1 Study of Forest Litter

As a result of a study of forest conditions in virgin stands last year which showed about 16 per cent greater pore space in virgin stands as compared with adjacent cultivated fields, this phase of the study will be extended to cover second growth forest, grazed woodlands, and plantations. The study will primarily be confined to the upper 9 inches of soil.

A second phase of the study carried on during the past year included base exchange in upper horizons of virgin stands. Dr. Auten will continue this phase of the study to determine the relation of calcium and magnesium content of litter to hydrogen-ion concentration in the forest floor. If time permits he will extend this study to the determination of relative amounts of calcium and magnesium contained in the leaves of the more common species in our region. The availability of calcium is an important factor in general soil fertility. The result so far obtained justifies this extension of this phase of the study.

#### Ts-12 Oak Yield Study

The logical outcome of the preparation of yield tables on even-aged stands of oak made on the basis of fully stocked stands of second growth, is the application of these results to understocked stands. As far as time permits, with the force available to the Station, studies of this type will probably be initiated in southeastern Ohio.

#### Mc-1 Management Cutting

For the current year the work on this project will be limited to the remeasurement of reproduction on plots on the Clark County State Forest.

#### T-1 Types

A further study will be made of the types on river bottomland especially on the western coal fields of Kentucky and the upper Mississippi valley. The purpose of this work will be to complete the work on the forest types of the Central States region for the use of the general type committee.

Reports and Articles - 1930

In Print

- Winters, Robert K. Suitability of the Liljenstrom Dendrometer for  
Reading Diameters of Trees in Black Walnut  
Plantations. Journal of Forestry, April, 1930, Vol. XXVIII,  
No. 4, pp. 511-514. ✓
- Day, Ralph K. Grazing Out the Birds.  
American Forests and Forest Life, September, 1930.  
pp. 555-557, 594. ✓
- 
- Grazing the Farmwoods in the Central States.  
Michigan Agriculturist, November, 1930. ✓
- 
- Protection from Grazing is Essential to the Welfare  
of the Farmwoods of the Central States.  
Proceedings of the First Central States Forestry  
Congress. December, 1930. ✓
- Auten, J. T. How Dry Is It?  
Michigan Agriculturist, October, 1930. ✓
- Kellogg, L. F. What Species Shall We Plant?  
Proceedings of the First Central States Forestry  
Congress. December, 1930. ✓
- 
- The Measurement of Yield in Forest Plantations.  
Ohio Academy of Science, Abstract - 1929. A?
- McCarthy, E. F. The Central Hardwood Forests - A Research Task.  
Proceedings of the First Central States Forestry  
Congress. December, 1930. ✓
- Barrett, L. I. Possibilities of Fire Extinguishing Chemicals in  
Fighting Forest Fires.  
Journal of Forestry, February, 1931, Vol. XXIX, 31  
No. 2, pp. 214-218. ✓

Submitted for Publication

- McCarthy, E. F. and Yellow Poplar Primer.  
Kellogg, L. F. U.S.D.A. Farmers' Bulletin.
- Auten, J. T. A Comparison of Porosity of Virgin Forest and  
Cultivated Soils.

Project (Fp-1)

Study of yield in black locust plantations.

Purpose

To provide a yield table and information as to the most desirable method of spacing and other methods of management for this species in plantation.

Status

A continuing phase of the study of older plantations.

Cooperation

Study of the locust borer will be carried in conjunction with this study. A graduate student of the Ohio State University may undertake study of nitrogen fixation.

Date of Completion

Yield phase to be completed at the end of one season's work.

Form of Publication

Circular or Farmers' Bulletin.

Assignment

L. F. Kellogg

## Project (Pa-1)

Woodland Grazing Project. This project in accordance with the recommendation contained in the 1930 report has been divided into five phases as follows:

- Phase (a) - Reconnaissance Phase.
- Phase (b) - Reconstruction Phase.
- Phase (c) - Livestock Management Phase.
- Phase (d) - Growth and Yield Phase.
- Phase (e) - Economic Phase.

### Purpose

General Study of the relation of grazing to farmwoods in the Central States region.

Phase (a) Preliminary survey of conditions in the farmwoods as related to the practice of grazing.

Phase (b) Study of the recovery of farmwoods following the exclusion of livestock.

Phase (c) To determine possible methods of livestock management in the farmwoods compatible with the production of timber.

Phase (d) To determine the effect of grazing on the growth and yield of farmwoods beyond the reproductive stage. The effects of grazing on the reproduction will be covered by the extensive data secured under the reconnaissance phase and it is the purpose of this study to compare the growth of grazed and ungrazed areas by periodic remeasurements of permanent sample plots, especially paired areas.

Phase (e) To make an intensive study of the economic phases of the grazing problem to secure adequate data for the purpose of appraising the relative returns to be expected from grazing and timber production in the woodlots.

### Status

Phase (a) Field work completed. Compilation of plot data nearly completed. Report outlined and in progress of preparation.

Phase (b) Extensive field work completed. Analysis of plot data eighty per cent complete. Manuscript being prepared covering the extensive data.

- Phase (c) An important phase of the grazing project, recommended for study in the Annual Report for 1930. Preliminary plans have been drawn up for the initiation of this study during the spring of 1931.
- Phase (d) A number of paired areas, suitable for establishment of such permanent sample plots, have been examined and selected for establishment.
- Phase (e) Active work will not be undertaken on this phase at the present time, but will be delayed pending active work on the Forest Survey project for this region.

#### Plans for Current Year

- Phase (a) Complete analysis and report.
- Phase (b) Complete analysis of plot data. Complete and publish bulletin covering this extension data. Prepare working plan outlining future development of this phase. Establish permanent sample plots for the continuation of the study of this phase by following for a period of years a number of the semi-permanent plots previously established.
- Phase (c) Establish proposed Pinney-Purdue study. Prepare a working plan outlining future development of this phase.
- Phase (d) Preparation of a general working plan for this phase of the project and location and establishment of a minimum of four such paired areas for the three broad forest types in the region.
- Phase (e) Prepare a working plan tentatively outlining the future development of this phase. All data which have a bearing on this problem will be collected in connection with the other phases, or otherwise as the opportunity affords.

Cooperation

Phases (b), (c), and (d) with Purdue Agricultural Experiment Station.

Date of Completion

Phase (a) - September, 1931.

Phase (b) - June, 1931.

Phases (c), (d), and (e) - Indefinite.

Form of Publication

Phase (a) - Farmers' Bulletin or Miscellaneous Circular of the Department of Agriculture, entitled, "Grazing as a Factor in the Present Condition of Farmwoods of the Central States."

Phase (b) - Technical Bulletin of the Purdue Agricultural Experiment Station, entitled, "Studies in Indiana Farmwoods" I. "Regeneration of Farmwoods Following the Removal of Livestock."

Eventually the various phases of the study will be combined into a Technical Bulletin of the Department of Agriculture on the "Relation of Grazing to the Farmwoods of the Central States."

Assignment

Ralph K. Day. Certain studies under phases (b), (c), and (d) assigned jointly with Daniel DenUyl of the Purdue Agricultural Experiment Station.

Project (TS-12)

Yield of second-growth, even-aged stands of upland eastern hardwoods containing 30 per cent or more of oak.

Purpose

Preparation of tables from field data already assembled.

Status

Field measurements already completed. Volume tables already constructed from field measurements. Computation completed for individual plots - now ready for punching on cards. Original records at Columbus, computed records in Washington.

Cooperation

With Appalachian Forest Experiment Station, Allegheny Forest Experiment Station and state and private agencies.

Date of Completion

1931 for yield table.

Form of publication

Preliminary publication - yield and volume tables to be followed by Departmental Bulletin after further accumulation of silvicultural data.

Assignment

E. F. McCarthy and Junior Forester.

Project (T-1)

Classification of forest types for the Central States region.

Purpose

1. To name and describe the forest types of the region.
2. To bring the various forest agencies into accord as far as possible on a classification of types adequate to their needs.
3. Correlation of this type classification with those of other adjoining regions to the central agency of the forest types committee, Society of American Forester.

Status

A tentative classification has already been presented to the Ohio Valley Section, Society of American Foresters. This classification was then transmitted to the major committee of the Society of American Foresters and is still subject to some revision.

Plans for the current year

A small amount of field work in the stream bottom section of western Kentucky. Reorganization and description of the present classification.

Cooperation

Committee of Ohio Valley Section, Society of American Foresters.

Foresters and other interested agencies in the region.

Completed

During current year.

Form of publication

As a part of National Committee Report.

Assignment

E. F. McCarthy

### Project (M-1)

The study of litter as developed under different forest conditions.

A. Relation to soil porosity.

B. Base exchange in litter.

### Purpose

A. To determine the effect of litter upon porosity of soil under different conditions developed by cutting, fire, grazing, plantations.

B. Calcium and magnesium will be studied first in its relation to base exchange especially with reference to acidity. Release of calcium and magnesium by decomposition of litter.

### Status

Continuation of last year's work.

### Cooperation

Departments of Soils and Chemistry, Ohio State University.  
Others may be developed.

### Date of Completion

Separate phases of this study will be completed during the year.

### Form of Publication

As each unit is completed, publication will be sought in such journals as are suitable for the material.

### Assignment

J. T. Auten